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IDENTIFICATION OF THE IMMATURE FORMS OF SOME COMMON SOIL-INHABITING WEEVILS, WITH NOTES ON THEIR BIOLOGY

By BRENDA M. MAY*

(*Received 3 December 1965*)

ABSTRACT

Keys are given for the separation of larvae and pupae of the following curculionids which are associated with crops and pastures: *Graphognathus leucoloma* (Boheman), *Asynonychus cervinus* (Boheman), *Phlyctinus callosus* Boheman, *Otiorhynchus sulcatus* (Fabricius), *Mandalotus miricollis* (Broun), *Catoptes compressus* Broun, *Cecyropa discors* Broun, *Desiantha maculata* Blackburn, *Listroderes delaiguei* Germain, *L. costirostris* Schönherr, *Hyperodes bonariensis* Kuschel. Biological, descriptive, and ecological notes are included.

INTRODUCTION

The curculionids, feeding as they do on plant materials, include many pests of considerable economic importance, and damage caused by their larvae extends to both foliage and roots. Identification of the larvae is of considerable importance, since the bionomics of the different species, and hence their control measures, are by no means identical.

The keys for larval and pupal separation presented here are designed to assist in the identification of species which may be encountered in the course of agricultural and horticultural investigations. In the descriptive notes details of chaetotaxy have been included where they are considered necessary for recognition.

All except three of the species spend their pre-adult life underground, feeding on roots and later pupating nearby. The subterranean clover weevil *Listroderes delaiguei* Germain probably feeds on foliage as well as roots, while the vegetable weevil *Listroderes costirostris* Schönherr and the stem weevil *Hyperodes bonariensis* Kuschel are foliage feeders and only enter the soil to pupate when fully fed. They are frequently encountered in samples, since the prepupal stage can last from 4 to 14 days, during which time the larvae are free and fairly active.

Well grown larvae can usually be identified in the field with a 10× hand lens, but younger stages often require closer study. Photographs of the adults have been included for reference.

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LABORATORY METHODS

All the species dealt with in the present study were collected as larvae in the field and reared to adults in the laboratory.

Larvae which were not fully fed, as shown by the dark gut contents, were kept in petri dishes in the soil in which they were found; pieces of their food plant were added. The fully grown larvae are opaque and creamy white. Adults were reared successfully from pupae placed between folded and slightly dampened filter paper where the degree of contact was adequate for emergence.

The behaviour of larvae of *Mandalotus miricollis* Broun feeding on clover roots was observed on small plants grown in damp tissue paper in 3 × 1 in. glass tubes. Eggs were introduced near the roots, and the resulting larvae grew to second instar.

Eggs were obtained from most of the species by enclosing adult weevils in petri dishes supplied with pieces of the food plant resting on damp filter paper. In some cases the eggs were pushed down between the glass and paper, while in others they were laid in, or on, the food plant.

CHARACTERS USED FOR SEPARATION

Larvae

In general, weevil larvae are immediately distinguished from those of other coleopterans by the complete absence of legs. Larvae of the family Anthribidae, which possess extremely small legs, do not occur in the soil.

Head capsules of most larvae are exserted, the whole head being visible and free from the thoracic folds. In the tribe Naupactini, however, which includes *Graphognathus leucoloma* (Boheman) and *Asynonychus cervinus* (Boheman), the rather colourless head is partially retracted into the thorax, but the black mandibles remain very prominent. The head capsules of the different species also vary in colour and colour pattern.

Abdominal setae present useful differences in number, arrangement, colour, and type. In cases where setae have been described as "not visible," they are usually present but can be seen only under high magnification.

Spiracles are not particularly noticeable in many of these weevils, but are good diagnostic characters for *Listroderes* spp. and for *Desiantha maculata* Blackburn.

Terminal segments of the abdomen are often characteristically shaped and may be modified to provide adhesion of the larva to its food plant, as in *Mandalotus miricollis, Catoptes* spp., and *Hyperodes bonariensis.*

Pupae

Weevil pupae are opaque and usually creamy white. Two or three days before emergence the adult insect becomes visible through the pupal skin. The eyes darken first, then the mandibles, followed by the other extremities, and finally the cuticle, complete with scales and setae. The prepupa does not spin a cocoon but constructs a protective earthen cell by rotating with considerable energy, cementing and smoothing the walls with droplets of a thick fluid secreted from the anus. In *Graphognathus leucoloma* the walls of the cell are so thickly coated that they become quite smooth and shiny.

As in the adult, the possession of a rostrum carrying the mouthparts is a distinguishing factor. Differences between genera and species are most noticeable in the type, numbers, and arrangement of the bristles and in the pseudocerci, which are often in the form of spines on the apical segment of the abdomen. In pupae of the short-nosed weevils (Adelognatha), the dehiscent cusps at the apex of mandibles are very prominent. They are present on the teneral adults but usually drop off when the pupation chamber is torn open for emergence. The vestigial hind wings of some flightless weevils are much more easily seen in the pupa, since the pterothecae in which they are enclosed are relatively large.

KEY FOR SEPARATION OF LARVAE

1. Head colourless; partially retracted into prothorax, leaving mandibles prominent (Fig. 1a) ..... 2.
   Head coloured; exserted (Fig. 1b) ..... 3.
2. Abdominal segments 1–7 with 5 post-dorsal setae on posterior fold; spiracular seta 1, on median fold, small but distinct (Fig. 2a). Setae pale. Mature larvae large (13 × 6 mm) ..... *Graphognathus leucoloma*
   Abdominal segments 1–7 with 4 visible post-dorsal setae on posterior fold; spiracular seta 1, on median fold, not visible (Fig. 2b). Setae orange. Mature larvae small (9 × 4 mm) ..... *Asynonychus cervinus*
3. Abdominal spiracles conspicuous ..... 4.
   Abdominal spiracles inconspicuous ..... 5.
4. Abdominal spiracles with air tubes forming a spine-like projection (Fig. 3) ..... *Desiantha maculata*
   Abdominal spiracles surrounded by dark crescent-shaped areas (Fig. 7c) ..... 10.
5. Head pale yellow, with or without markings ..... 6.
   Head orange ..... 8.
6. Last 3 abdominal segments with coarse, blunt setae and with 3 epipleural (upper lateral) setae. Ninth segment not modified (Fig. 4b) ..... *Cecyropa* spp.
   All abdominal segments with fine, pointed setae and with 2 epipleural setae. Ninth segment strongly sclerotised and characteristically shaped ..... 7.

7. Sclerotised areas of ninth abdominal segment with inner margin straight; angled in lateral view. Lateral lobes of anal segment without visible setae (Fig. 5a, b) ..... *Mandalotus miricollis*
   Sclerotised areas of ninth segment with inner margin curved; gently rounded in lateral view. Lateral lobes of anal segment each with a distinct seta (Fig. 5c, d) ..... *Catoptes* spp.
8. Ventral setae not visible. Terminal segments quadrate with curved, trailing setae (Fig. 4a). Very small species, mature larvae 6 × 1.5 mm ..... *Hyperodes bonariensis*
   Not as above. Much larger species ..... 9.
9. Prothorax strongly sclerotised. Lateral lobes of abdominal segments narrowly rounded. Anal segment tucked in (Fig. 6b) ..... *Otiorhynchus sulcatus*
   Prothorax lightly sclerotised. Lateral lobes of abdominal segments broadly rounded. Anal segment protruding (Fig. 6a) ..... *Phlyctinus callosus*
10. Head colour pattern well defined (Fig. 7a). Epipharynx with 3 anterior lateral setae on each side (Fig. 7b). Mature larvae larger (12 × 4 mm) ..... *Listroderes costirostris*
    Head colour pattern fainter and less sharply outlined. Epipharynx with 2 anterior lateral setae on each side (Fig. 7d). Mature larvae smaller (7 × 2.5 mm) ..... *Listroderes delaiguei*

KEY FOR SEPARATION OF PUPAE

1. Mandibular cusps present (Adelognatha) (Figs. 8–14). Secondary pterothecae (hind wings) present or absent ..... 2.
   Mandibular cusps absent (Phanerognatha) (Figs. 15–17). Secondary pterothecae present ..... 8.
2. Pronotum, head and femora with most bristles hooked apically 3.
   All bristles straight or curved, not hooked ..... 6.
3. Median apical pronotal bristles close together and much smaller than lateral bristles (Fig. 11) ..... *Otiorhynchus sulcatus*
   Apical pronotal bristles more or less evenly spaced and of equal length ..... 4.
4. Pseudocerci hornlike (Fig. 12) ..... *Mandalotus miricollis*
   Pseudocerci (lateral terminal spines) bristular ..... 5.
5. Secondary pterothecae present (Fig. 10) ..... *Phlyctinus callosus*
   Secondary pterothcae absent (Fig. 13) ..... *Catoptes* spp.
6. Bristles long, fine, pale and straight (Fig. 14) ..... *Cecyropa* spp.
   Bristles short, stout, dark and curved ..... 7.
7. Apical pronotal bristles set on large, pinched tubercles. Larger species, length 12.0–13.0 mm (Fig. 8) ..... *Graphognathus leucoloma*
   Apical pronotal bristles set on small tubercles. Smaller species, length 8.0–9.0 mm (Fig. 9) ..... *Asynonychus cervinus*
8. Abdominal tergites with only 1 strong bristle on each side. Very small species, length 2.5–3.0 mm (Fig. 18) ..... *Hyperodes bonariensis*
   Abdominal tergites with 2 or more strong bristles on each side. Larger species, length 6.0–10.5 mm ..... 9.

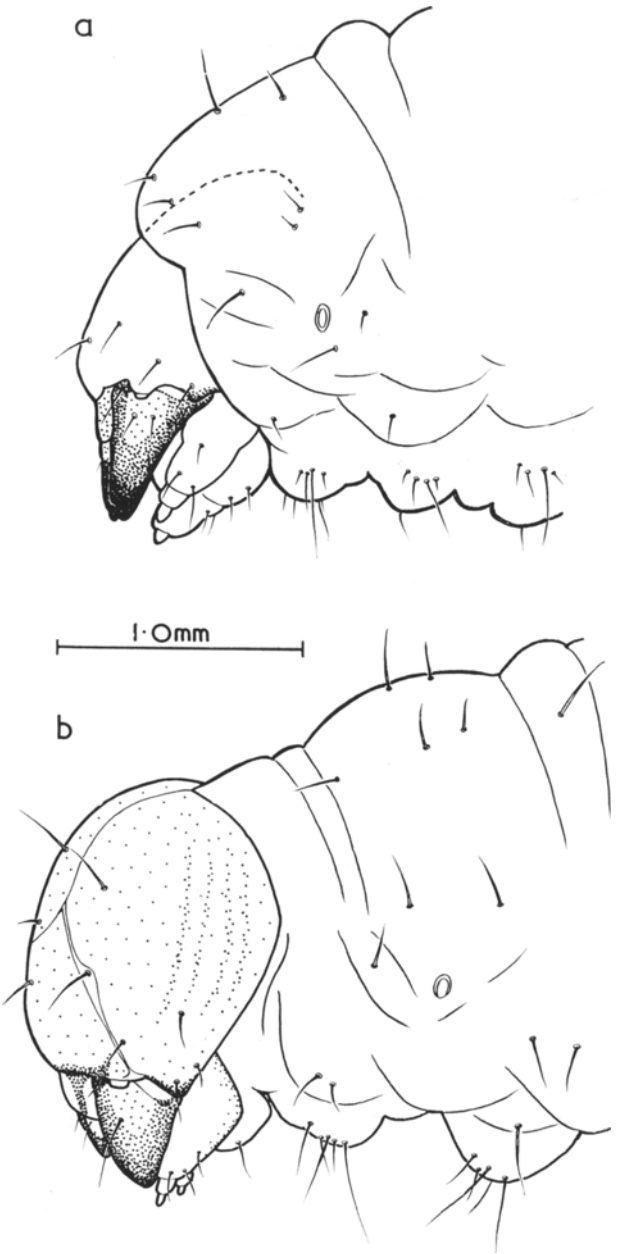


Fig. 1.—a. Partially retracted larval head (*Asynonychus cervinus* (Boheman)).
b. Exserted larval head (*Phlyctinus callosus* Boheman).

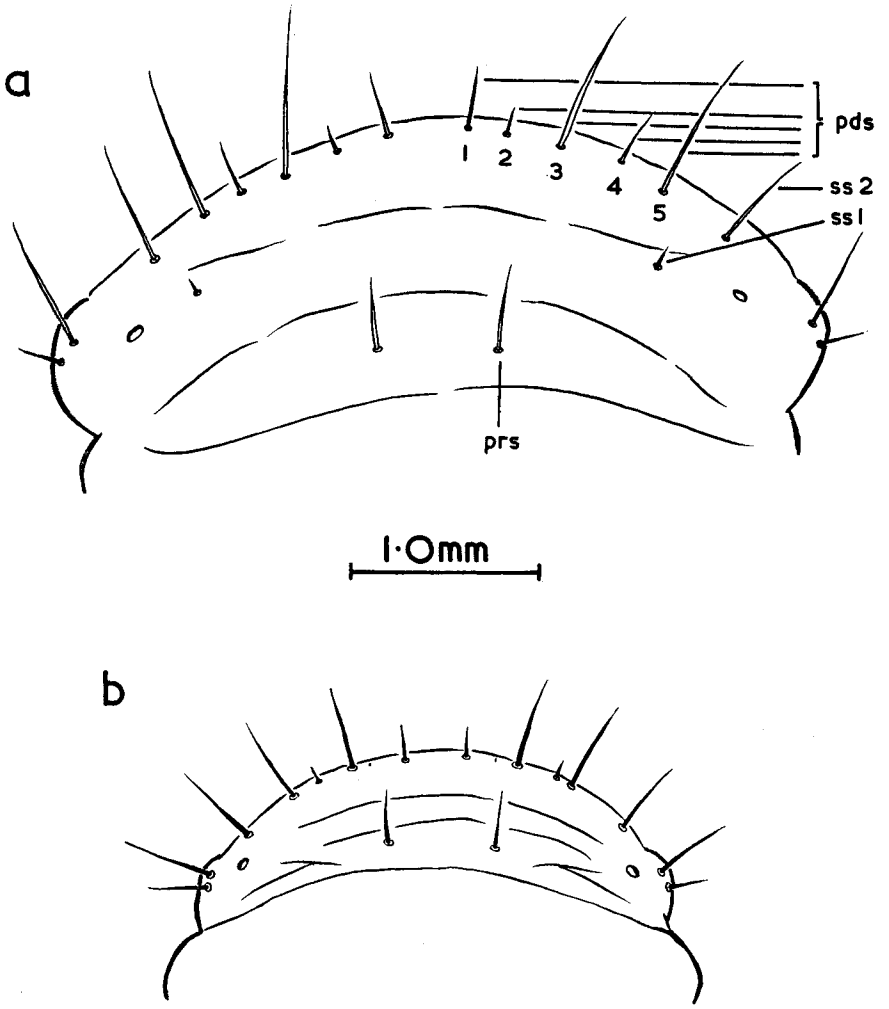


Fig. 2.—Dorsal setae of larval abdominal segment VII.
a. *Graphognathus leucoloma* (Boheman).
b. *Asynonychus cervinus* (Boheman).
Abreviations: prs. = prodorsal seta; pds. = post dorsal setae; ss. = spiracular setae.

9. Pronotum of equal width and length. Bristles longer and paler (Fig. 15) ..... *Desiantha maculata*
Pronotum wider than long. Bristles short and dark ..... 10.

10. Pronotum with both pairs of discal bristles strong and more or less equidistant (Fig. 16) ..... *Listroderes delaiguei*
Pronotum with anterior pair of discal bristles weak or absent; if present, then farther apart than posterior pair (Fig. 17) ..... *Listroderes costirostris*

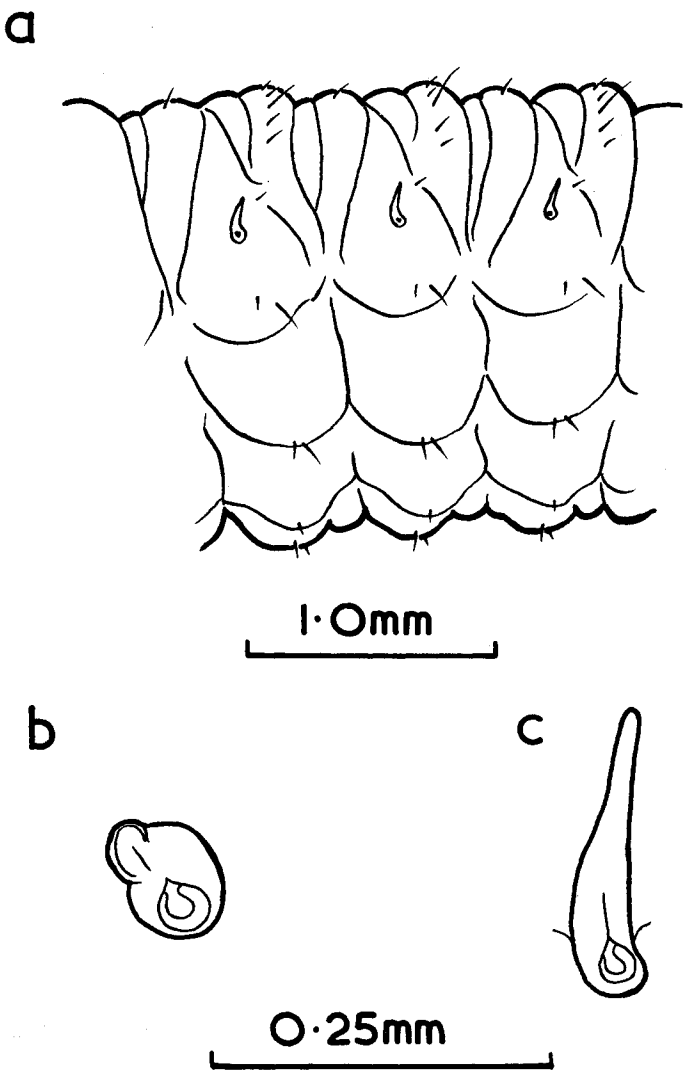


Fig. 3.—Larva of *Desiantha maculata* Blackburn.
a. Abdominal segments III to V.
b. Prothoracic spiracle.
c. Abdominal spiracle.

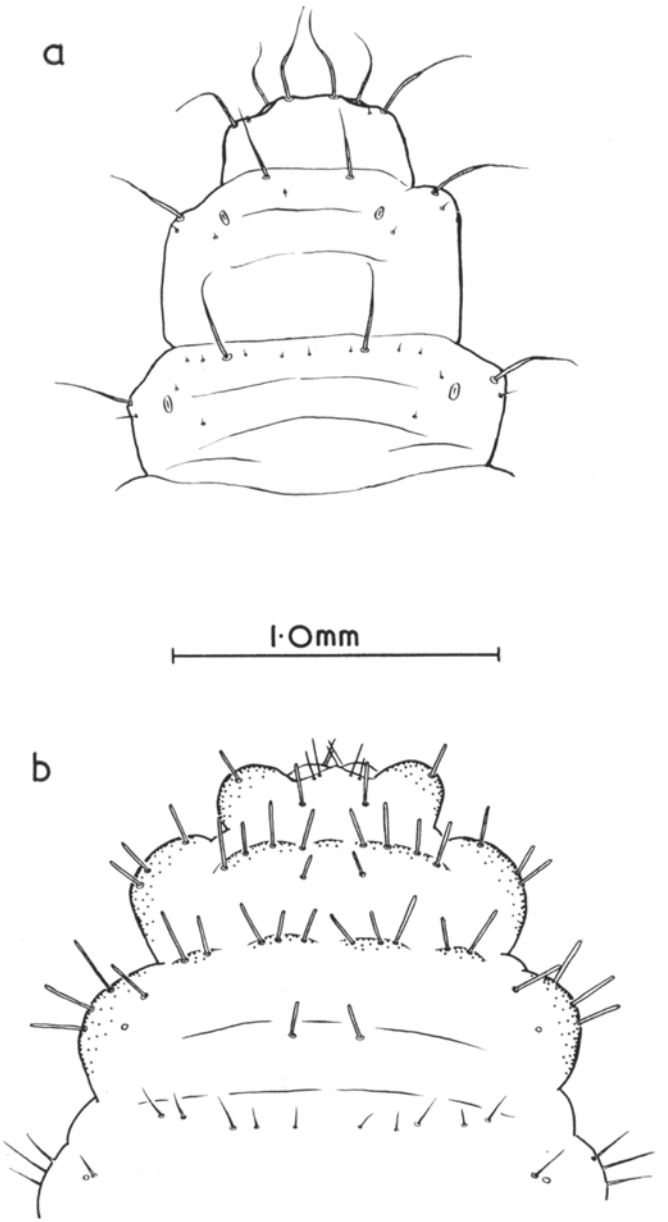


Fig. 4.—Terminal segments of larvae.
a. *Hyperodes bonariensis* Kuschel.
b. *Cecyropa discors* Broun.

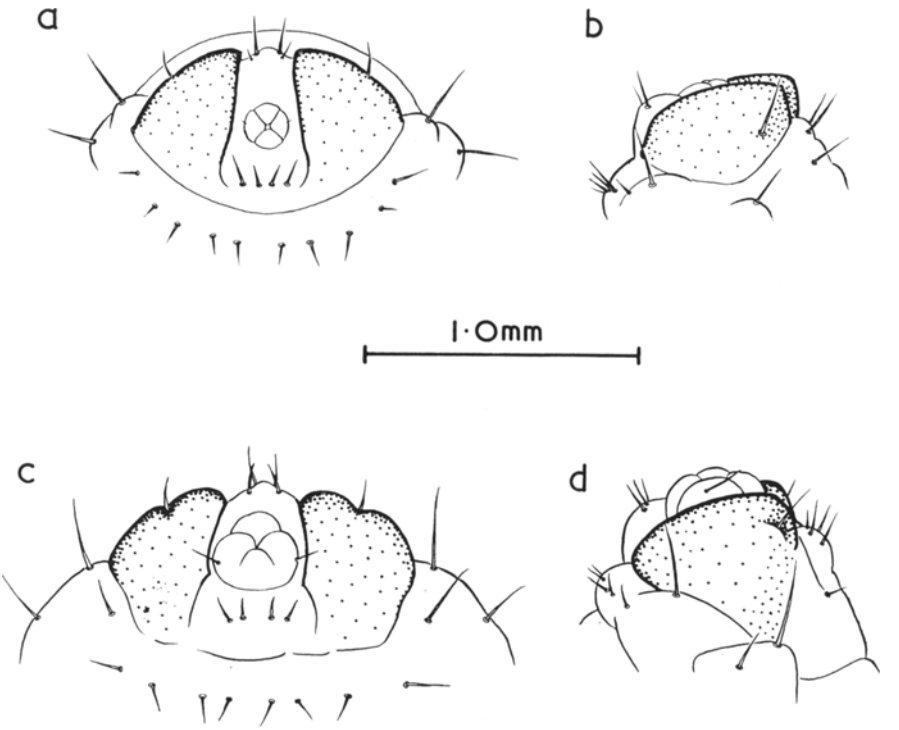


Fig. 5.—Terminal segments of larvae.
a. *Mandalotus miricollis* (Broun), ventral view.
b. Lateral view.
c. *Catoptes compressus* Broun, ventral view.
d. Lateral view.

BIOLOGICAL AND DESCRIPTIVE NOTES

Graphognathus leucoloma (Boheman) White-fringed weevil (introduced). (Figs. 2a, 8; Plate 1c). Maximum size of prepupae: 13.0 × 6.0 mm. Length of pupae: 12.0 — 13.0 mm. Average size of eggs: 0.82 × 0.56 mm. Reproduction: parthenogenetic.

The eggs are white and broadly oval. They are laid in clumps of 20 to 60 amongst ground litter and on plants where they are pushed between adjoining surfaces and cemented together. Between February and May, 1,104 eggs were laid by a caged adult fed on dandelion (*Taraxacum officinale* Weber) leaves. Experiments (Anonymous 1956) in U.S.A. have indicated that oviposition is influenced by the food plant on which the adult is fed. Weevils fed on peanut (*Arachis hypogaea* L.) foliage, for instance, laid an average of 1,600 eggs compared with an average of only 4 eggs for those fed on grasses. The eggs can withstand

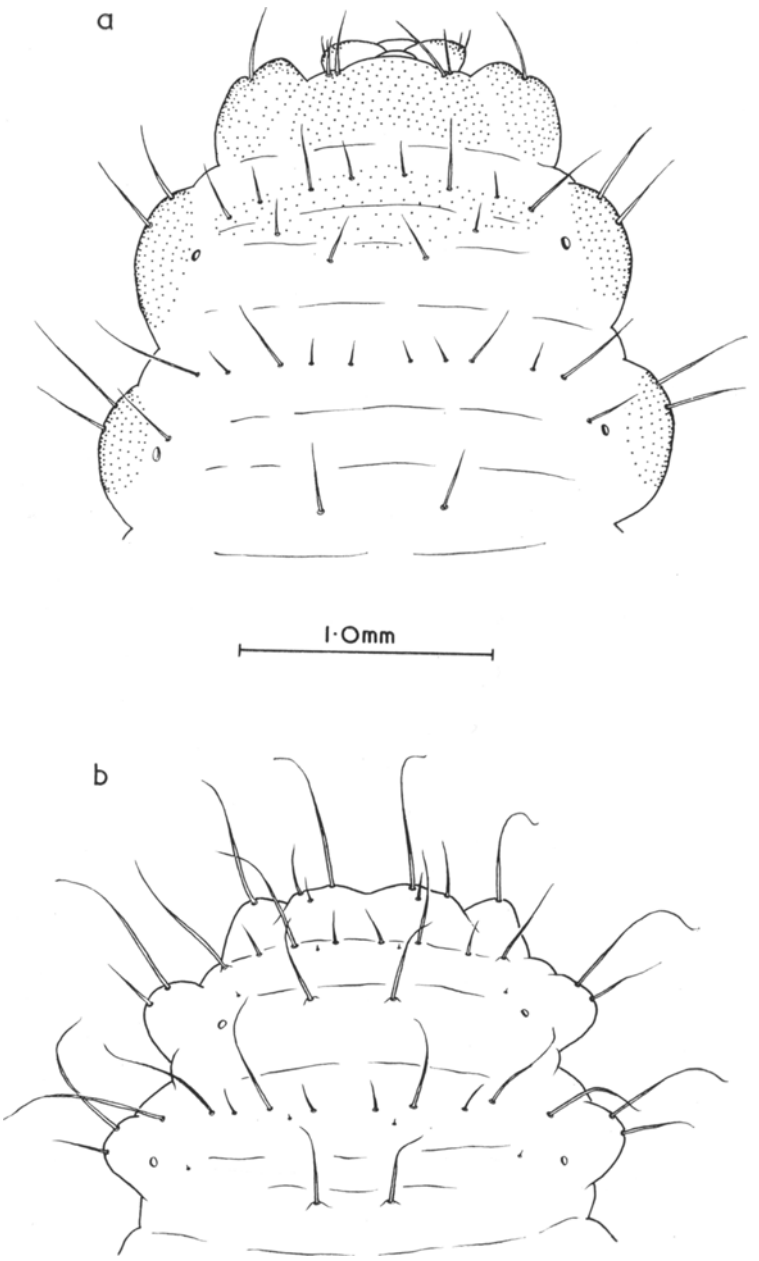


Fig. 6.—Terminal segments of larvae.
a. *Phlyctinus callosus* Boheman.
b. *Otiorhynchus sulcatus* (Fabricius).

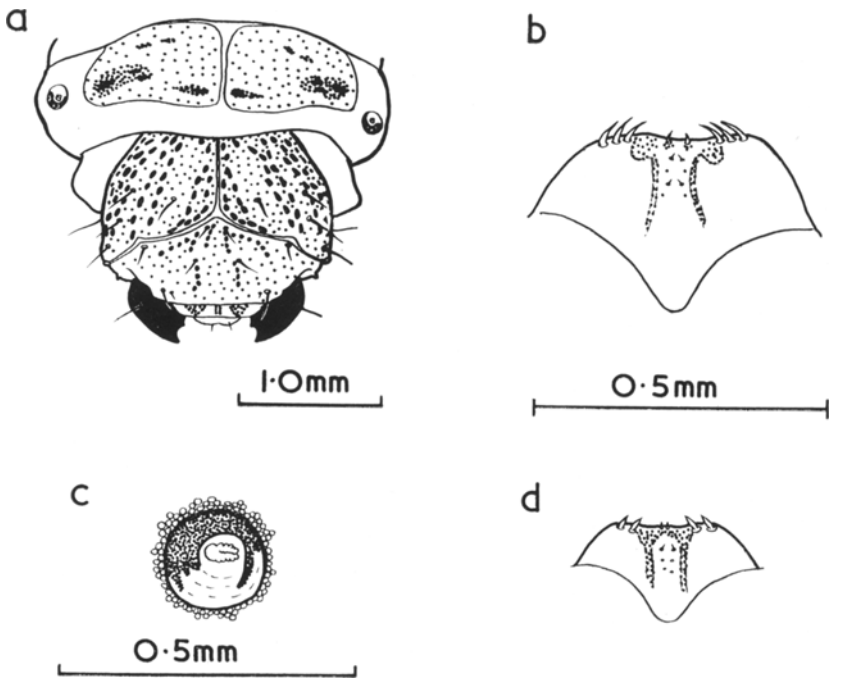


Fig. 7.—a. *Listroderes costirotris* Schönherr, head and prothorax.
b. Epipharynx.
c. Abdominal spiracle.
d. *L. delaiguei* Germain, epipharynx.

long periods of desiccation, and hatch when conditions become suitable. Some which were kept dry for approximately 6 weeks, hatched 8 days after being dampened.

The larva is stout and vigorous with a colourless head partly hidden in the thorax, so that the projecting black mandibles are its most noticeable feature. Larvae are to be found in the soil all the year round and pupation occurs from early October until April. In pots of clover at Mount Albert, Auckland, they took between 9 and 10 months to reach maturity. There must be considerable local variation, however, since Todd (1964) stated that in Hawke's Bay, larval development extends over a period of about 17 months.

The pupa is furnished with bristles which are very stout and curved, especially on the pronotum and femora, and the pseudocerci on the terminal segment are short. The thecae of the mandibular cusps are nearly as large as the rostrum. The secondary pterothecae are as long as the primary (elytra), and both are tipped with a small spine. The hind wings are non-functional in the adult.

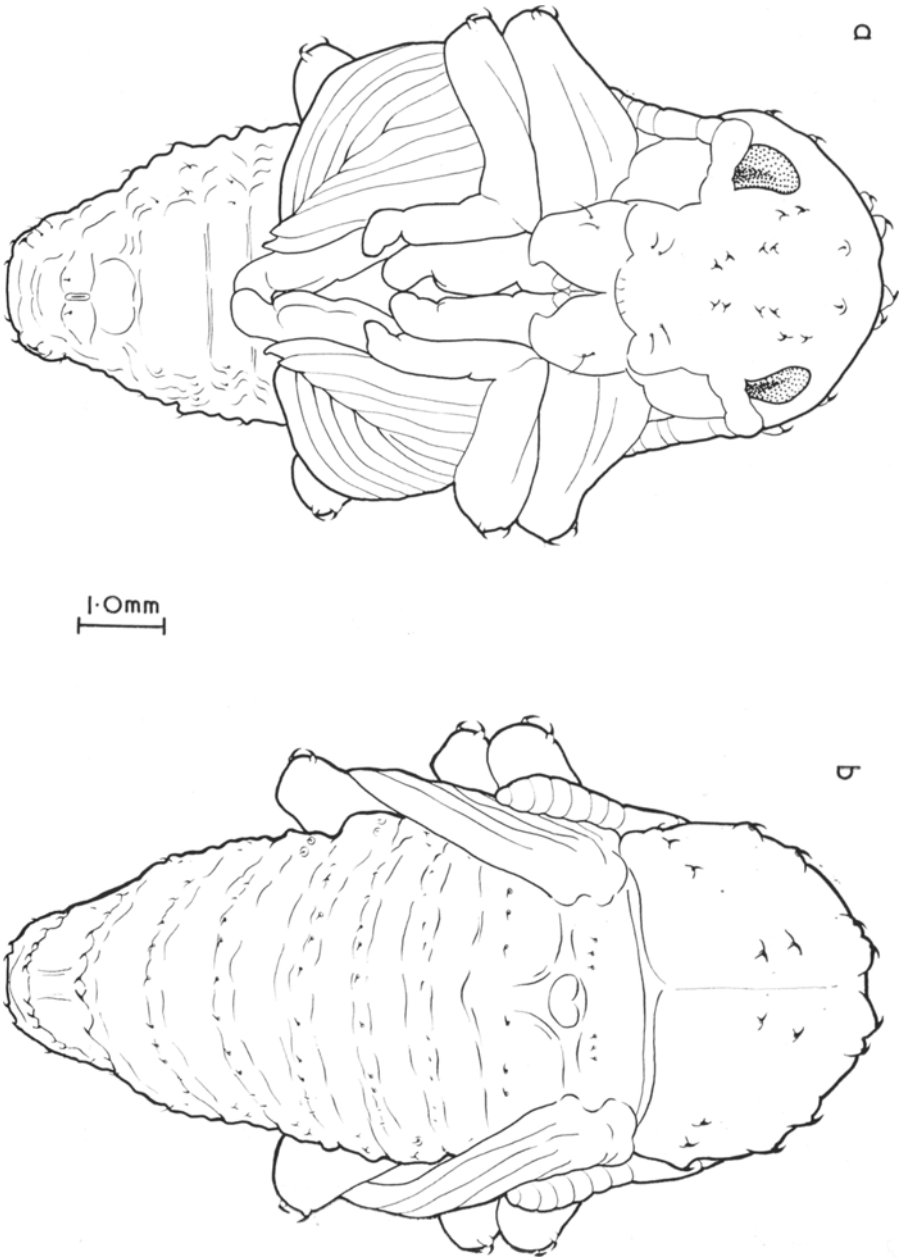


Fig. 8.—Pupa of *Graphognathus leucoloma* (Boheman).
a. Ventral view.
b. Dorsal view.

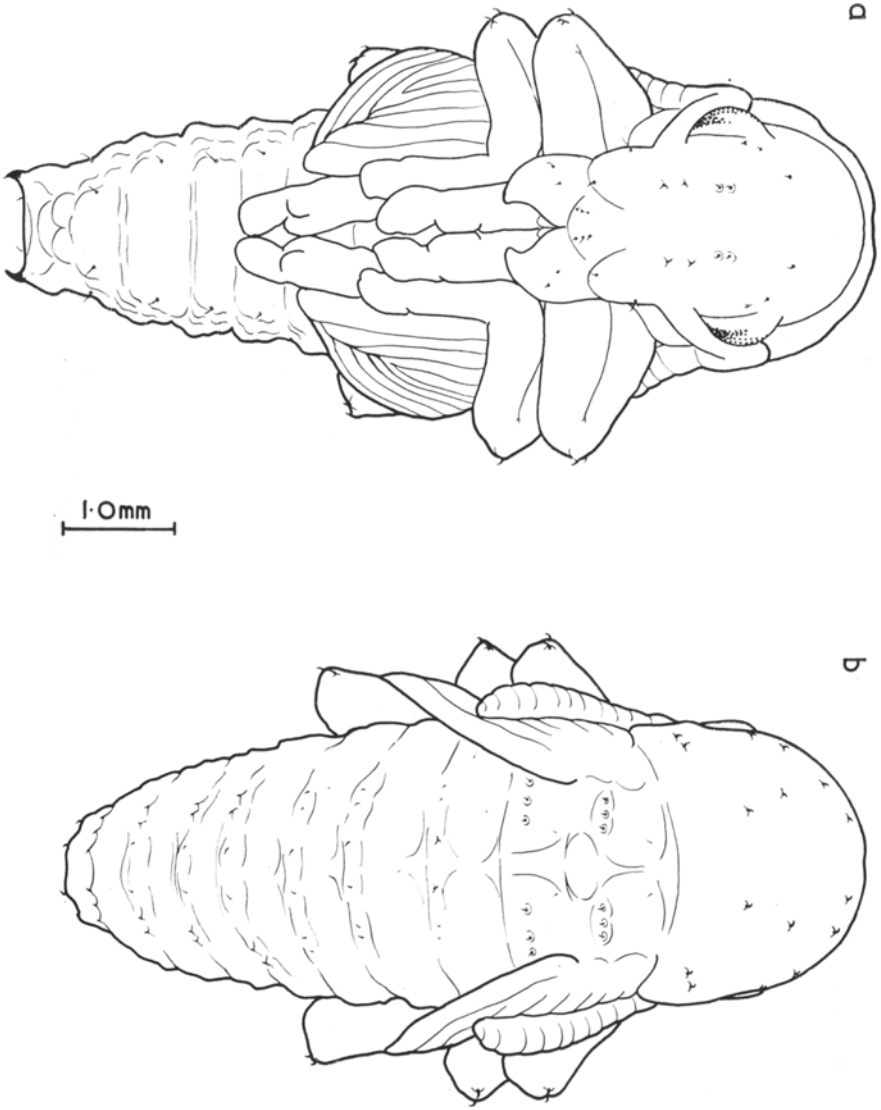


Fig. 9.—Pupa of *Asynonychus cervinus* (Boheman).
a. Ventral view.
b. Dorsal view.

Larval food plants. *Pinus* sp. seedlings, lucerne (*Medicago sativa* L.), white clover (*Trifolium repens* L.), water melon (*Citrullus lanatus* (Thunb.) Mansf.), peas (*Pisum sativum* L.), tomato (*Lycopersicum esculentum* (L.) Karsten), potato (*Solanum vulgare* L.), wheat (*Triticum aestivum* L.), and chou moellier (*Brassica oleracea* var. *ramosa* Alef.) are recorded for New Zealand. The status of *G. leucoloma*

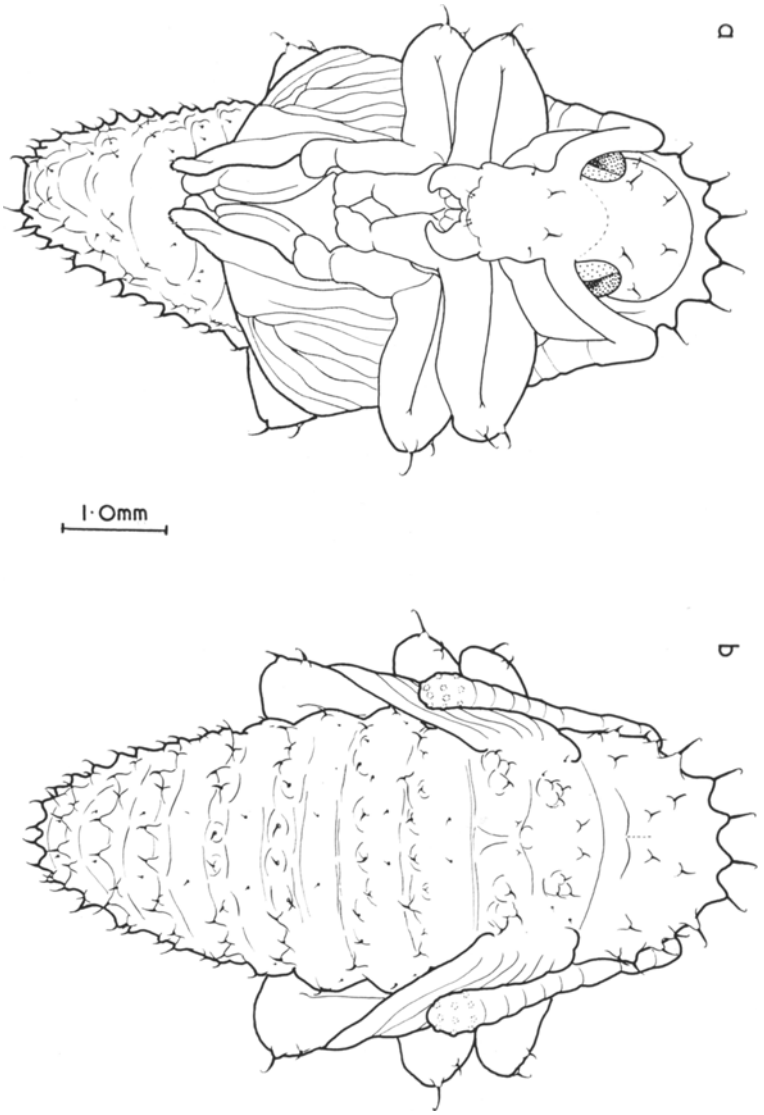


Fig. 10.—Pupa of *Phlyctinus callosus* Boheman.
a. Ventral view.
b. Dorsal view.

larvae in pastures is still uncertain. They are often very numerous. The evidence obtained so far suggests that though their preferred food may be legumes, they will feed on grass roots as well. In areas where the sward tends to become clover-dominant, their effect may be slightly beneficial, but on light land and sand dune country they can cause serious loss of ground cover.

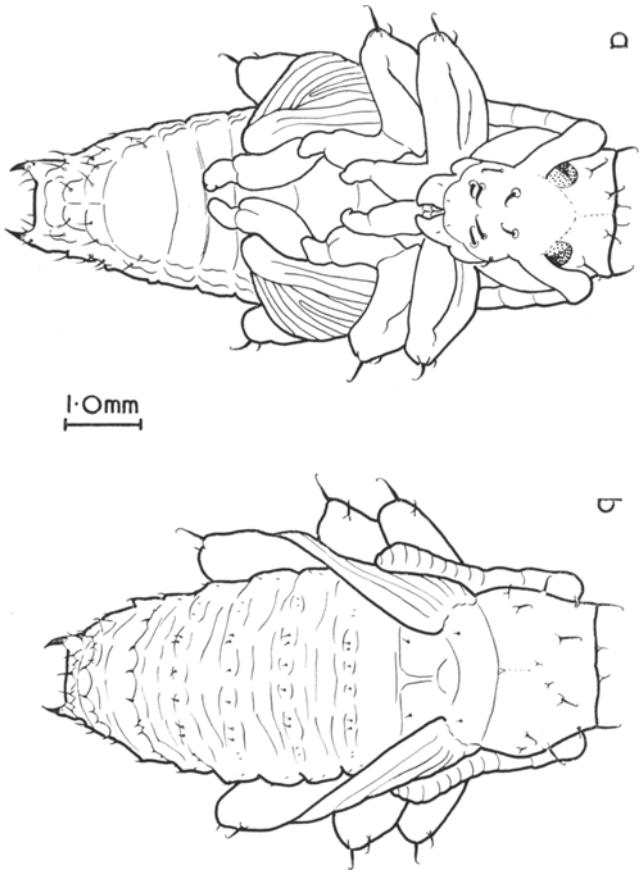


Fig. 11.—Pupa of *Otiorhynchus sulcatus* (Fabricius).
a. Ventral view.
b. Dorsal view.

Distribution. Throughout the North Island, including Wellington (1 larva from Titahi Bay, June 1963); Nelson (Perrott 1964) in the South Island.

Asynonychus cervinus (Boheman) (= *Pantomorus godmani* Crotch). Fuller's rose weevil (introduced). (Figs. 1a, 2b, 9; Plate 1d). Maximum size of prepupae: 9.0 × 4.0 mm. Length of pupae: 8.0–9.0 mm. Average size of eggs: 0.9 × 0.4 mm. Type of reproduction: parthenogenetic.

This species is closely related to *Graphognathus leucoloma,* and observations suggest that its biology is similar.

The eggs are golden yellow and shortly ovate. They are cemented together in clusters and pushed into any crevice or covering near the

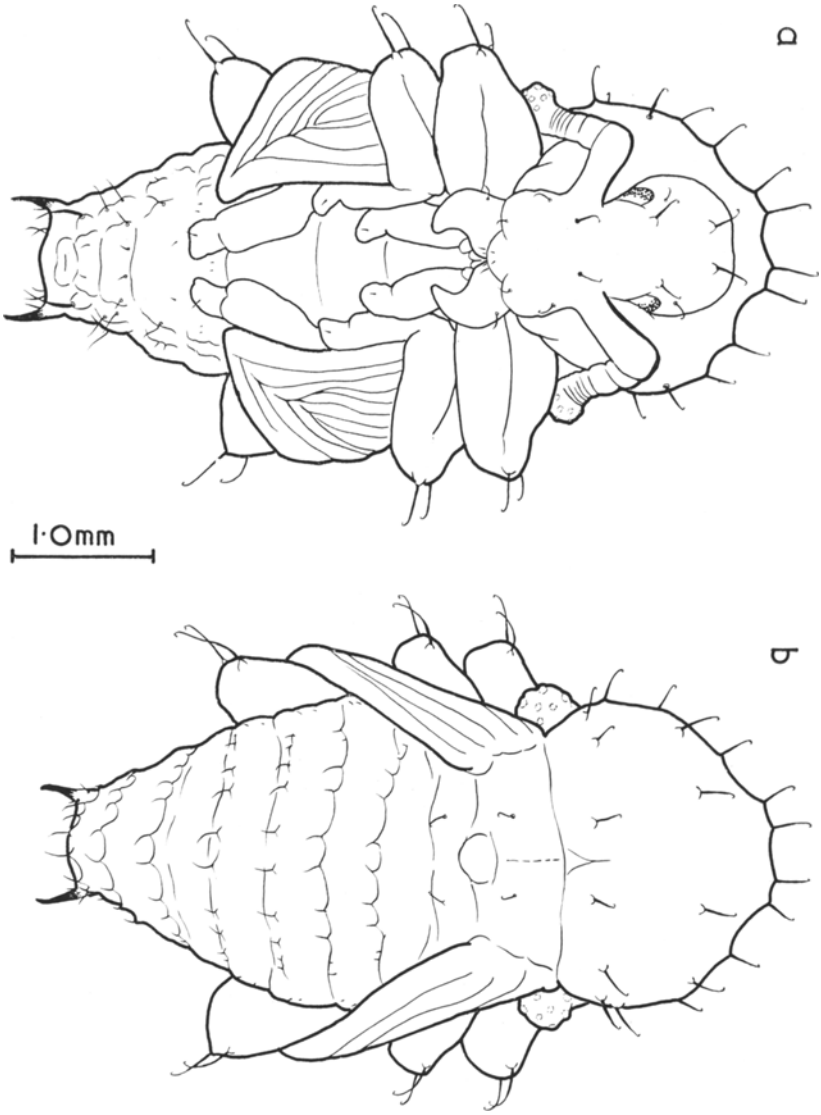


Fig. 12.—Pupa of *Mandalotus miricollis* (Broun).
a. Ventral view.
b. Dorsal view.

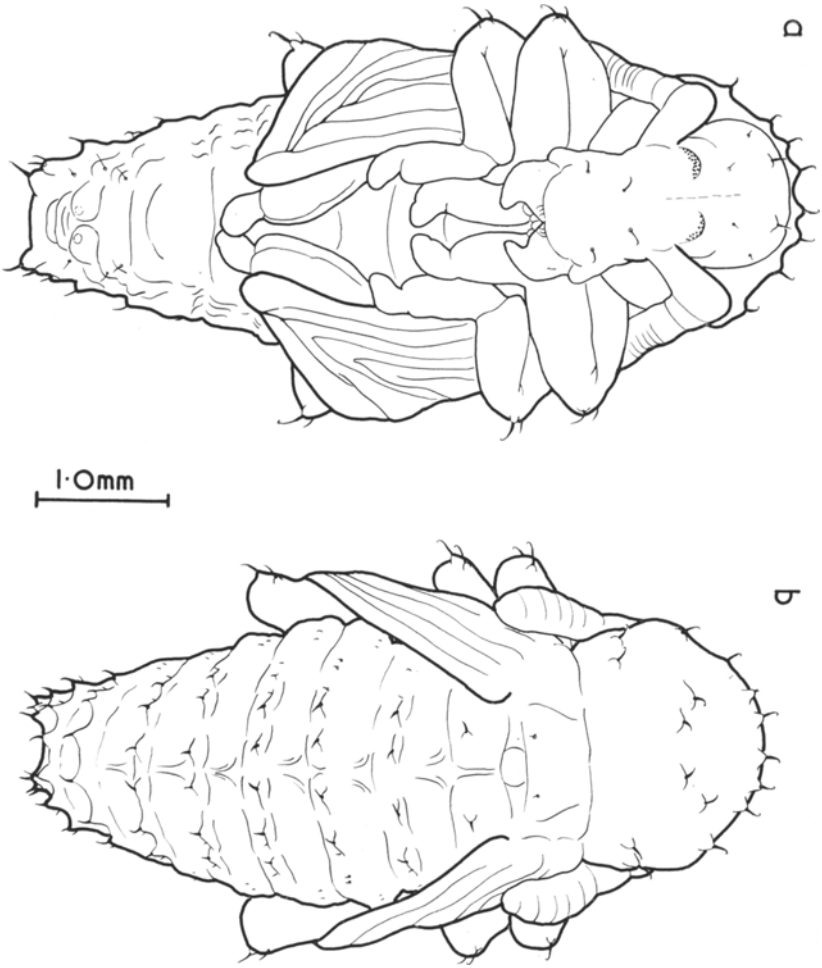


Fig. 13.—Pupa of *Catoptes compressus* Broun.
a. Ventral view.
b. Dorsal view.

ground. They are resistant to dry conditions, and the incubation time varies from 6 to 70 days.

The larva is smaller than that of *G. leucoloma* and in the first instar is coloured yellow. Otherwise the two species are alike in appearance and often occur together in the soil. The orange colour and the arrangement of the abdominal setae present the best characters for separation.

The pupa possesses very short, curved bristles and short, hornlike pseudocerci. The thecae of the mandibular cusps are prominent and

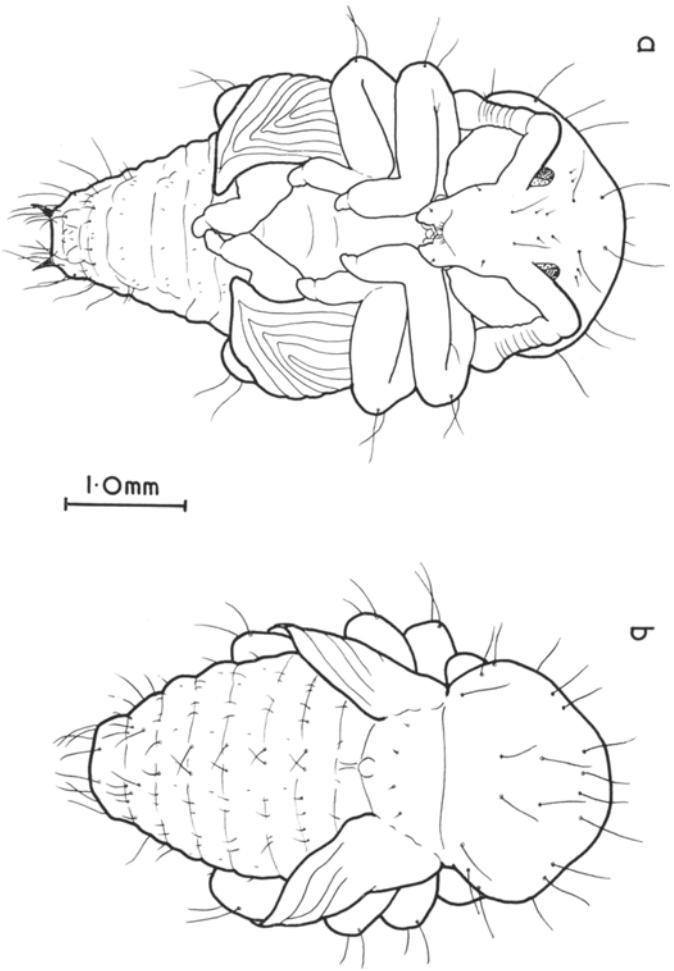


Fig. 14.—Pupa of *Cecyropa discors* Broun.
a. Ventral view.
b. Dorsal view.

those of the hind wings are easily seen in preserved specimens when the members separate and spread out. In adult weevils where the elytra are soldered along the suture, the wings are reduced to thread-like vestiges.

Larval food plants. A. cervinus is very common in gardens with light soil, where larvae show a preference for the roots of ornamental shrubs. Existing records for New Zealand refer to adult damage only. Larvae have been reared on white clover roots in the laboratory, and in pasture it is likely that they feed on these rather than on grasses. They were taken from beneath lucerne near Taupo. In California the

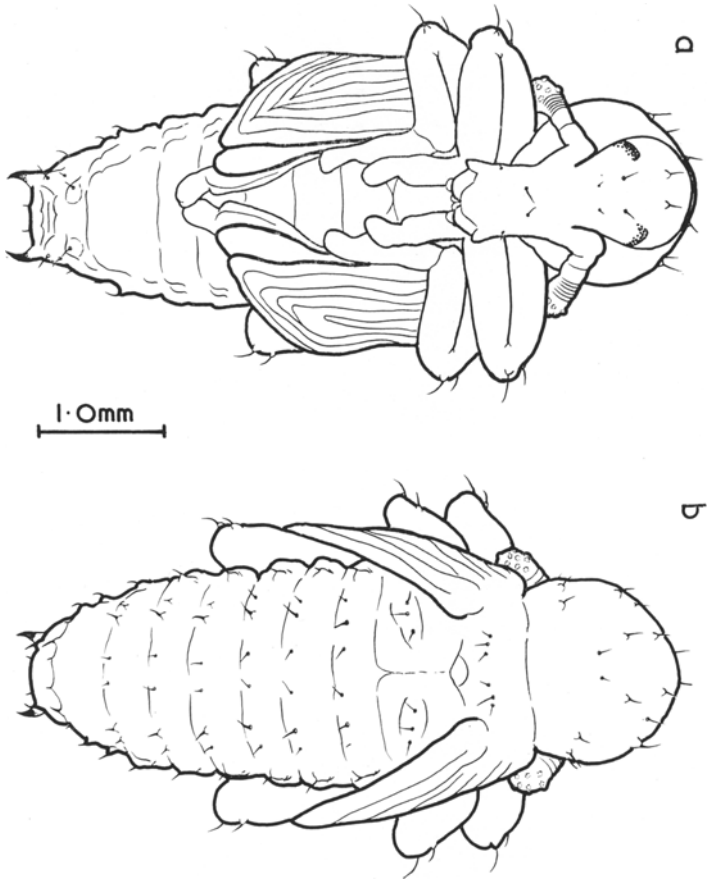


Fig. 15.—Pupa of *Desiantha maculata* Blackburn.
a. Ventral view.
b. Dorsal view.

roots of young citrus are attacked (Dickson 1950). This may also occur in the Kerikeri district where adults are plentiful and larvae have been taken from soil in the orchards.

Distribution. Throughout the North Island; Nelson in the South Island.

Phlyctinus callosus Boheman. Garden weevil (introduced). Figs. 1b, 6a, 10; Plate 1e). Maximum size of prepupae: 10.0 × 3.5 mm. Length of pupae: 7.0–8.0 mm. Average size of eggs: 0.90 × 0.45 mm. Reproduction: parthenogenetic.

The eggs are oblong and creamy white, becoming blackish at the poles as they mature. Batches of up to 70 are laid at intervals of approximately 7 days. Captive ovipositing adults pushed eggs, one by

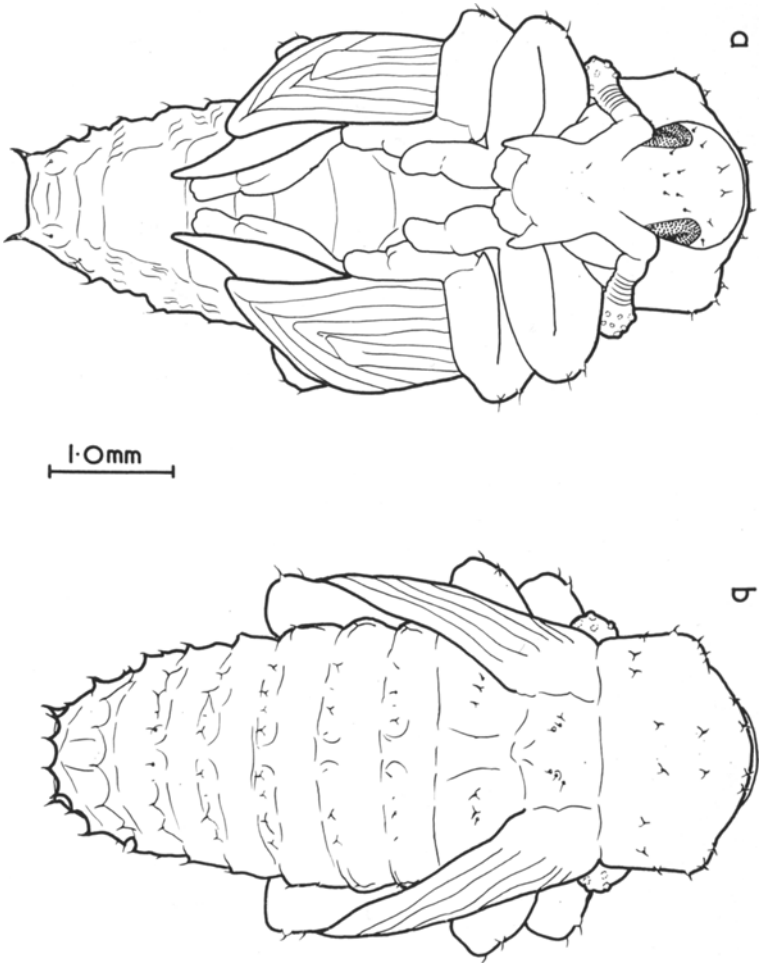


Fig. 16.—Pupa of *Listroderes delaiguei* Germain.
a. Ventral view.
b. Dorsal view.

one, into the hollow stalks of old clover leaves, but probably any plant tissue is utilised which is soft and about to decay. Oviposition records were not obtained for a complete year, but eggs were laid throughout the winter and well into summer, and, according to the temperature, took from 7 to 21 days to hatch.

The larvae are very active. They are recognisable by the orange head and rather long body hairs. These features are rather similar in *Otiorhynchus sulcatus* but the head of *P. callosus* is smaller, the prothorax is more lightly sclerotised and the terminal segments are differently shaped. The two species do not often occur together.

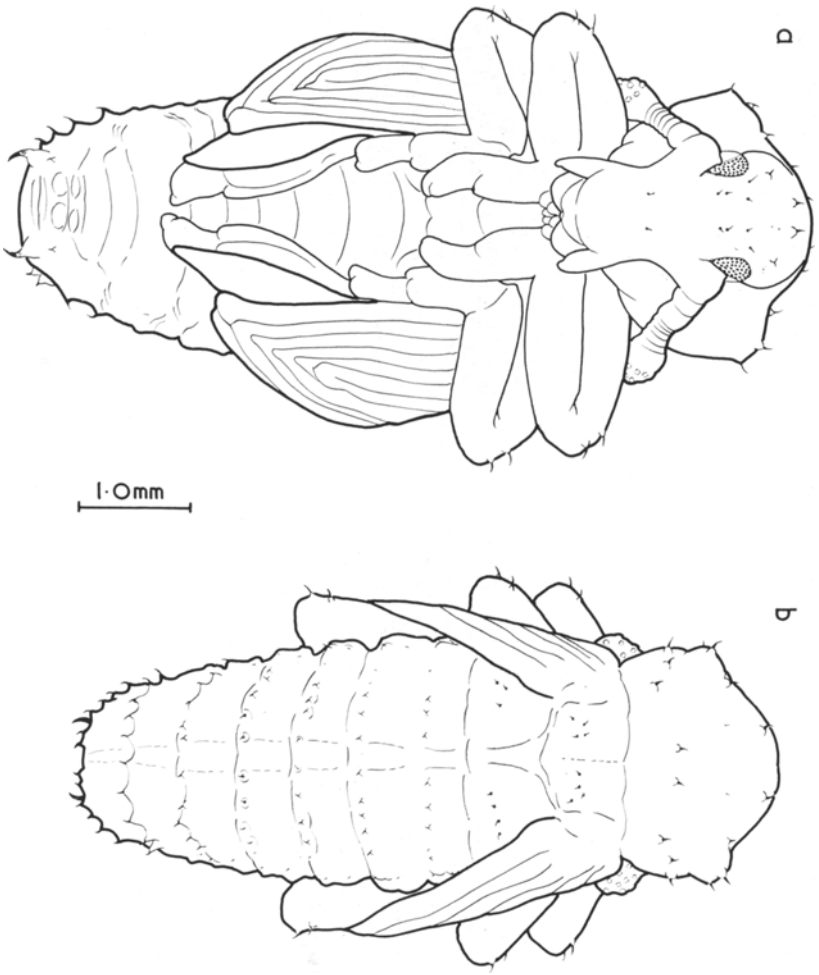


Fig. 17.—Pupa of *Listroderes costirostris* Schönherr.
a. Ventral view.
b. Dorsal view.

The pupa is provided with stout, hooked bristles, mounted on prominent tubercles, but the pseudocerci are inconspicuous and differ little from other abdominal bristles. The secondary pterothecae protrude well beyond the primary, although as hind wings in the adult, they are vestigial. The thecae of the mandibular cusps are fairly noticeable.

Larval food plants. There appears to be a preference for tap-rooted plants such as carrot (*Daucus carota* L. var. *sativa* DC.) and parsnip (*Pastinaca sativa* L.), and for bulbs and corms, e.g., Spanish iris (*Iris xiphium* L.) and cyclamen (*Cyclamen persicum* Mill.), into

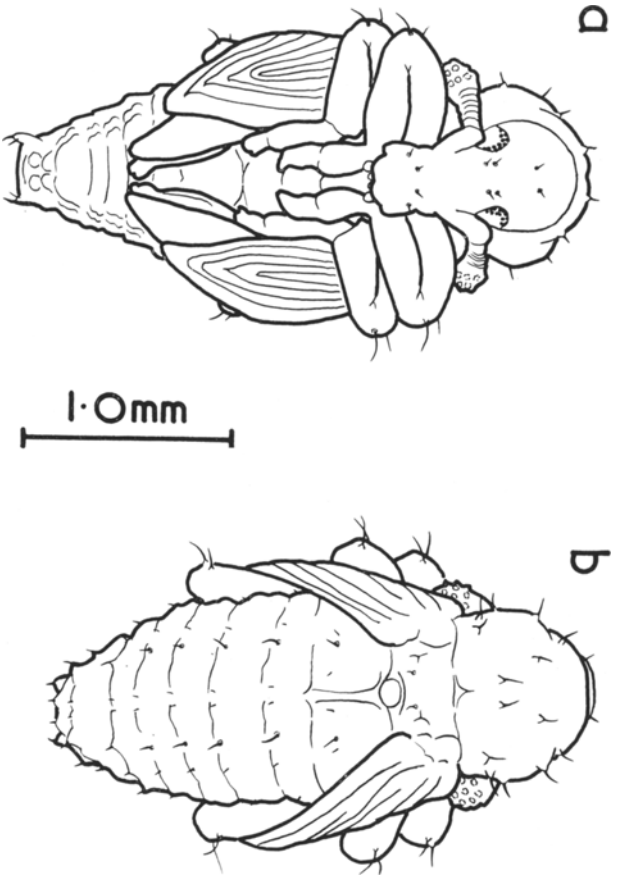


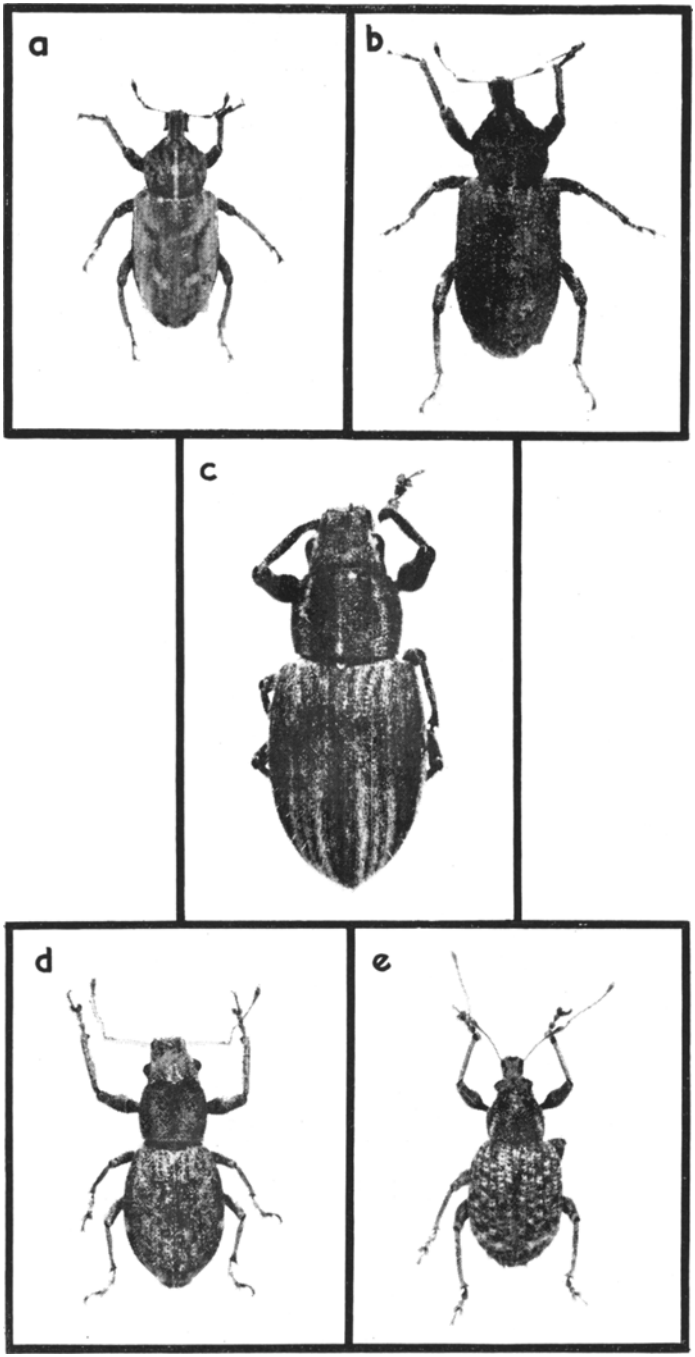
Fig. 18.—Pupa of *Hyperodes bonariensis* Kuschel.
a. Ventral view.
b. Dorsal view.

which the larvae burrow. However, they have also been bred on strawberry (*Fragaria* sp. cult.) roots, and on perennial ryegrass (*Lolium perenne* L.). They are frequently turned up in pasture.

Distribution. Warmer parts of the North Island; Nelson in the South Island.

Otiorhynchus sulcatus (Fabricius). Black vine weevil (introduced). (Figs. 6b, 11; Plate 2e). Maximum size of prepupae: 11.0 × 4.0 mm. Length of pupae: 10.0–10.5 mm. Average size of eggs: 0.65 mm diameter. Reproduction: parthenogenetic.

The eggs are almost spherical and are pearly white when first laid, becoming light brown after 2 days. They are laid in surface litter or on plants, either singly or in small batches. An adult may lay over



Alan Underhill

1,000 eggs but there is considerable mortality among newly hatched larvae unless the soil is friable enough to permit their easy entry (Smith 1927).

The larva is superficially similar to that of *Phlyctinus callosus* but, in addition to the characters for separation mentioned in the key, the head is proportionately larger and the body setae are more tapering, with a peculiarly bent appearance. The larvae are strong and very active. In the laboratory, specimens in cyclamen corms stopped feeding in mid-June, pupated in early August, and emerged as adults about 2 weeks later.

The pupa of *O. sulcatus,* by contrast with that of *P. callosus,* does not possess secondary pterothecae and has strong, hornlike pseudocerci. There are 4 pairs of strong, hooked bristles on the rostrum, and the thecae of the mandibular cusps are prominent.

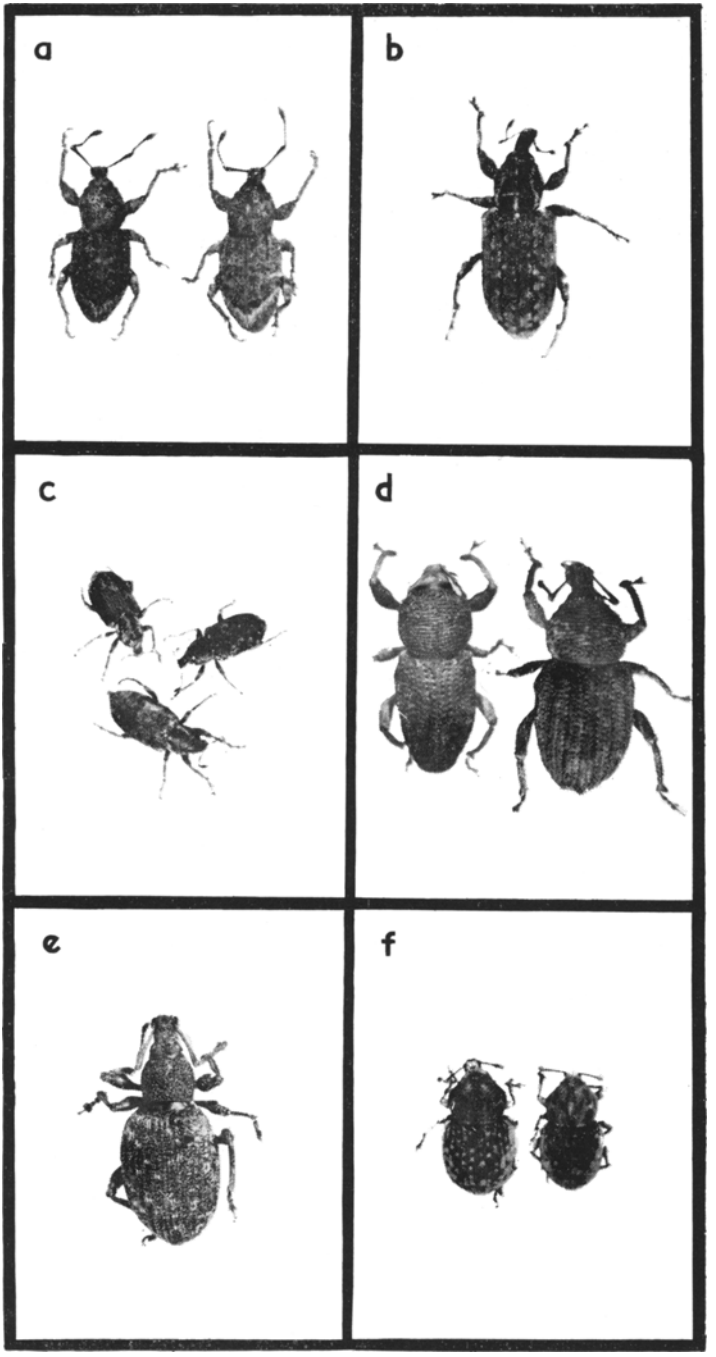
Larval food plants. O. sulcatus has been a major pest of strawberries overseas and undoubtedly could be in New Zealand if regular chemical control programmes were relaxed. The larvae chew the roots and burrow into the crowns. Polyanthus (*Primula polyantha* Mill.) is attacked in the same way. The tap roots of carrot and parsnip, the tubers of yam (*Oxalis crenata*), and the corms of cyclamen, particularly in green-houses, are tunnelled. Young shrubs such as *Hamamelis* sp. and grape vines (*Vitis vinifera* L.) are girdled at soil level and the roots stripped. Larvae have been dug from pasture at Winchmore, Canterbury.

Distribution. Throughout the South Island and cooler parts of the North Island. Rarely taken north of Auckland.

Mandalotus miricollis (Broun) (possibly endemic). Figs. 5a, 12; plate 2d). Maximum size of prepupae: 7.0 × 2.5 mm. Length of pupae: 5.0–6.0 mm. Size of eggs: 0.8 × 0.4 mm. Reproduction: sexual.

The eggs are oblong and white when laid, later turning dark at the poles. They may be placed in clusters on foliage, but are more usually pushed inside stalks of clover leaves in a double row of up to 16. The initial puncture appears to be made by chewing. The eggs collapse quickly in dry conditions and do not remain viable. In the insectary the peak period for oviposition was March/April, with a lesser period of activity in late July/August. The incubation time varies from 28 days in September to 7 days in March.

Plate 1.—Adult weevils.
a. *Listroderes delaiguei* Germain.
b. *Listroderes costirostris* Schönherr.
c. *Graphognathus leucoloma* (Boheman).
d. *Asynonychus cervinus* (Boheman).
e. *Phlyctinus callosus* Boheman.
Magnification 4×



Alan Underhill/S. A. Rumsey

The larva is rather inconspicuous and its movements are slow. The head is pale yellow with a narrow, dark frontal margin (epistoma) and dark mandibles. The ninth abdominal segment is curved downwards and sclerotised to form an angular "rocking base" with the protruding lobes of the anal segment providing adhesion even to very small roots. First instar larvae have been dug from a depth of 6 in., suggesting that they move downwards soon after hatching. Older larvae penetrate to 10 in. or more. They are most plentiful during May/August, samples from some areas containing 30 per sq. ft.

The pupa is somewhat rotund and carries a fringe of slender, hooked bristles around the pronotum. Thecae of the mandibular cusps and the dark, slender pseudocerci are very prominent. Secondary pterothecae are absent. Pupation takes place within the top 4 in. of the soil, in smooth but unlined cells, during September to January.

Larval food plants. White clover is the only larval food plant so far confirmed, although adults will feed on the foliage of most grasses and some weeds. Clover grows so strongly in Auckland province that it appears to suffer little or no set-back.

Distribution. In the North Island only, in North Auckland and as far south as Meremere.

Catoptes compressus Broun (endemic). (Figs. 5b, 13: Plate 2a). Maximum size of prepupae: 7.5 × 2.5 mm. Length of pupae: 5.5–7.0 mm. Size of eggs: 0.7 × 0.3 mm. Reproduction: sexual.

The adults of *Catoptes compressus,* in some seasons, become very numerous between December and March when they may invade houses situated near farmland. In the immature stages and in its ecology this species shows great similarity to *Mandalotus miricollis* and, since they occur together in some areas, direct comparison may be useful.

The eggs are slightly more cylindrical than those of *Mandalotus* but the same oviposition sites are selected. Hatching occurs within 18–21 days in December and 14 days in January, indicating a response to temperature similar to that of *Mandalotus.* The eggs are equally intolerant of desiccation.

The larva differs in having a wider red-brown band on the frontal margin of the head and in the sclerotised ninth abdominal segment, which is rounded instead of angular. The larval stage occupies approximately 9 months.

Plate 2.—Adult weevils.
a. *Catoptes compressus* Broun.
b. *Desiantha maculata* Blackburn.
c. *Hyperodes bonariensis* Kuschel.
d. *Mandalotus miricollis* (Broun).
e. *Otiorhynchus sulcatus* (Fabricius).
f. *Cecyropa discors* Broun.
Magnification 4×. Photos a, b, c, d, f, by *Alan Underhill;* e. by *S. A. Rumsey.*

The pupa is more slender. It possesses hooked bristles but they are shorter and darker and the pseudocerci are bristulate and inconspicuous. Thecae of the mandibular cusps are prominent and secondary pterothecae are lacking.

Larval food plants. Larvae have so far only been taken from beneath pasture where they almost certainly feed on clover. However, since adults of several species of *Catoptes* have been incriminated of damaging foliage of brassicas, lucerne, and strawberries, the larvae should be sought in association with these plants also.

Distribution. North Auckland to Canterbury.

Remarks. Dr G. Kuschel has informed me that this species was wrongly identified in the past as *C. obliquesignatus* Schönherr.

Cecyropa discors Broun. Sand weevil (endemic). (Figs. 4b, 14; Plate 2f). Maximum size of prepupae: 6.0 × 1.5 mm. Length of pupae: 4.5–5.5 mm. Size of eggs: 0.8 × 0.6 mm. Reproduction: sexual.

The species of *Cecyropa* are all sand dune dwellers. The seedling stages of crops grown in dune country are sometimes badly damaged by the adults, but it is not yet known to what extent the larvae are harmful.

The eggs are sub-spherical and pearly white when laid, turning grey as they mature. They are easily desiccated and in their natural habitat the females probably burrow down to damp sand before ovipositing. In captivity they did not lay until a sprinkle of sand was provided beneath damp filter paper. Then, up to 4 eggs a day were placed singly among the grains. Hatching takes 11 days in February, 21 days in April, and 32 days in June.

The larva has a pale yellow head and is lightly sclerotised on the lobes of the last three segments, giving it a reddish tinge and making detection extremely difficult in light-coloured sand. It is distinguished by the unusual type of setae on these segments and by having 3 or 4 epipleural setae instead of the more usual number of 2. Pupation occupies 21–28 days in October.

The pupa, like the adult weevil, is proportionally broad. It is clothed with fine, rather long, pale bristles which, on the terminal segments, are longer than the hornlike pseudocerci. Secondly pterothecae are lacking and thecae of the mandibular cusps are inconspicuous. In the teneral adult, these deciduous cusps are small and straight and the scar, resulting from their loss, can be easily overlooked.

Larval and adult food plants. Larvae have been taken from amongst, and inside, the roots of yellow lupin (*Lupinus luteus* L.) and the sand convolvulus (*Calystegia soldanella* (L.) R.Br.), often at a depth of 18 in., and from roots of the composites *Crepis* sp. and *Hieracium* sp. They have also been taken in large numbers from beneath a paddock of subterranean clover on dune country near Palmerston North. Adults

have damaged foliage of onion (*Allium cepa* L.) and radish (*Raphanus sativus* L.) at Wanganui, turnip (*Brassica rapa* L.) seedlings at Foxton, and lucerne seedlings at Palmerston North.

Distribution. Species of *Cecyropa,* all extremely similar in appearance except for head capsule markings, occur on the foreshore all around the New Zealand coast and for many miles inland in sand dune areas.

Desiantha maculata Blackburn (introduced). (Figs. 3, 15; Plate 2b). Maximum size of prepupae: 7.0 × 2.5 mm. Length of pupae: 5.5–6.0 mm. Size of eggs: not known. Reproduction: sexual.

The white larva has an orange head which is paler and much smaller than that of *Phlyctinus callosus* and has a light median patch. The body setae are inconspicuous except for a few dark ones on the terminal segments. Those on the ventral side are short and stout. The most noticeable feature is the row of spine-like spiracles on each side of the body. Larvae usually occur in very light or sandy soil where they may sometimes be quite numerous. Some specimens, bred through to the adult stage, were well grown when found in May. They pupate and emerge during October.

The pupa is somewhat slender, with a longish rostrum but no mandibular cusps. The secondary pterothecae are clearly visible and remain as well developed wings on the adult. The pseudocerci are hornlike but small and only light sclerotised.

Larval food plants. Larvae of *Desiantha maculata* are root feeders but an Australian species *D. caudata* Pascoe is recorded by Squires (1964) as a foliage feeder on subterranean clover (*Trifolium subterraneum* L.) in New South Wales. The list of known food plants is small but varied: pine seedlings (Clark 1932), strawberries at Tauranga, lucerne at Himatangi and Waiterere, near Foxton. Larvae were dug from mixed pasture near Waiuku and Tuakau, from predominantly subterranean clover pasture on dune country near Palmerston North, and on the river silts of the Takapau plains in Hawke's Bay.

Distribution. Probably throughout New Zealand, in light soils.

Listroderes delaiguei Germain (= *Desiantha praemorsa* Lea). Subterranean clover weevil (introduced). (Figs. 7d, 16; Plate 1a). Maximum size of prepupa: 9.0 × 3.0 mm. Length of pupae: 6.0–8.0 mm. Size of eggs: 1.4 × 0.9 mm. Reproduction: parthenogenetic.

The life history of this species has not yet been followed completely, in New Zealand, and some of the present information is taken from the work of Squires in Australia.

The eggs are white and pyriform and are laid in clusters of 2–5. The peak of oviposition occurs in autumn.

The larva is pale dull yellow or distinctly green with a dark brown, rather square head, a row of grey spiracles along each side of the body,

and a dark thoracic shield. The dorsal setae are reduced to very short stubs, while those on the underside are represented only by low tubercles. Although larvae of this species are almost identical in appearance with those of *L. costirostris*, they are somewhat different in their habits. Both Newman (1929) and Squires (1964) have recorded the insect as a pest of subterranean clover in Australia, but whereas Newman considered that the larvae fed only on leaves and stems, denuding the plants of foliage, Squires stated that they bore deeply into the tap roots and just below the crowns, causing shoots above the injury to die. In New Zealand, *L. delaiguei* also appears to be associated with subterranean clover. The numbers of adults and larvae collected at any one time, have not as a rule been large, probably because subterranean clover usually comprises only a minor constituent of mixed pastures. However, on the very light soils of sand dunes, recent river silts and pumice country, subterranean clover is often sown exclusively or in major proportions and here, larvae of *L. delaiguei* are more abundant and may warrant further investigation.

The pupa is smaller and more slender than that of *L. costirostris* but is otherwise similar. Pupation occupies 11 days in Auckland in September.

Larval food plants. Subterranean clover. In Australia cape weed (*Cryptostemma calendulaceum* R.Br.) (present in frost-free areas in New Zealand), tomatoes, potatoes, and tobacco (*Nicotiana tabacum* L.), were also recorded by Newman (1929, 1931).

Distribution. Throughout the North Island; d'Urville Island.

Listroderes costirostris Schönherr (= *obliquus* Klug). Vegetable weevil (introduced). (Figs. 7a, b, c, 17; Plate 1b). Maximum size of prepupae: 13.0 × 5.0 mm. Length of pupae: 9.0–12.0 mm. Size of eggs: 0.8 × 0.6 mm. Reproduction: parthenogenetic.

The eggs are sub-spherical and pearly white at first, becoming dark grey as they develop. They are laid in damp debris and foliage on, or near, the ground. In Auckland adults emerge from September onwards, aestivate during the summer, and oviposit in March or April when eggs hatch in 2–3 weeks.

The larva varies in colour from yellow-green to bright green. Its appearance, especially when preserved in alcohol, is so similar to that of *L. delaiguei* that it can only be separated on very small details. The difference in head colour pattern can be detected through a hand lens, especially if both species are available for comparison, but the epipharynx can be adequately studied only when dissected and slide mounted. In the insectary larvae became fully fed on leaves of cats-ear (*Crepis* sp.) after 46 days (mid-June). As prepupae they were in the soil for a further 23 days before pupating in smooth-walled chambers near the soil surface. These periods would be extended slightly under field conditions. The larval period, nevertheless, is much shorter than for root feeding species.

The pupa is pale yellow-green and matures in 2–3 weeks. There are no mandibular cusps but the secondary pterothecae are well developed. Adults have been seen in flight in U.S.A. (Beckham 1953).

Larval food plants. The foliage of almost any vegetable is eaten and a wide variety of weeds, amongst which, hog-cress (*Coronopus didymus* L.) and chickweed (*Stellaria media* (L.)) are especially favoured.

Distribution. Throughout the North Island; in the South Island as far south as Oamaru.

Hyperodes bonariensis Kuschel. Stem weevil (introduced). (Figs. 4a, 18; Plate 2c). Maximum size of prepupae: 6.0 × 1.5 mm. Length of pupae: 4.5–5.0 mm. Size of eggs: 1.0 × 0.5 mm. Reproduction: sexual.

The life history of this species, which is a well-known pest of pasture grasses, has been dealt with by Kelsey (1958) and Pottinger (1961) for Canterbury, and by May (1961) for Auckland districts.

The eggs are greenish-black in colour, oblong, and are pushed either singly, or 2–5 in a row, beneath the surface of grass leaf sheaths.

The larvae feed within the stems, but descend to the soil when fully grown to prepare for pupation, this latter stage occupying 4 to 14 days. The prepupa is dense, creamy white, slender, with a light orange head marked with a paler pattern, and rather long, fine abdominal setae. As in *Listroderes* spp., the ventral side of the body is furnished with soft tubercles in place of setae. These, with the curved, trailing hairs of the terminal segments, provide the surface adhesion which becomes necessary when larvae migrate to fresh tillers.

The pupa is white with well developed secondary pterothecae but no mandibular cusps. Pupation usually takes place within the top 1 in. of soil.

Larval food plants. Ryegrass (*Lolium* spp.), cocksfoot (*Dactylis glomerata* L.), annual meadow grass (*Poa annua* L.), rough meadow grass (*Poa trivialis* L.), timothy (*Phleum pratense* L.), wheat, barley (*Hordeum vulgare* L.), oats (*Avena sativa* L.), seedling maize (*Zea mays* L.).

Distribution. In all pastoral areas of North and South Islands.

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